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Why Network Administrators Should Explore the “V” in K-V-M Switches

2007 ATEN

Computer video signals have continued to evolve over the last several decades during which an enterprise reference to the “computer” shifted from mostly mainframe and larger “minicomputers” to the distributed client-server model that prevails today. In parallel, the TV has come a long way from the small black and white consoles of the 50s to color to large screen TVs and now HDTV LCD TVs.

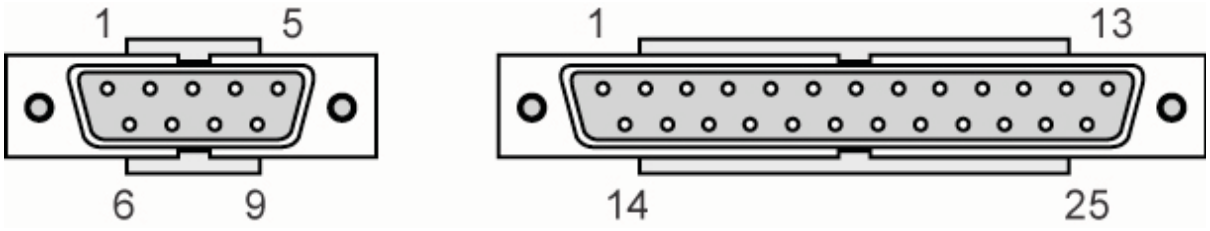
For data center administrators who are responsible for monitoring the screens of hundreds, and potentially thousands, of servers and PCs, video resolution becomes paramount for efficiency in the data center or server room. One such tool to aid in this effort is the KVM (keyboard/video/mouse) switch that enables IT professionals to easily and effectively manage servers and other network devices – within the data center or from remote locations.

This white paper will offer a technical glimpse into the “whys” behind the “V” in KVM and the importance of video resolution. The paper will also offer a historical perspective on video signals and chart the continuum to high video resolution resident in the KVM products of today.

The Video Resolution Evolution -- A Step Back in Time

Serial VDTs

Early mainframes and minis used serial terminals. These video display terminals (VDTs) were (and still are) monochromatic screens that display ASCII characters, often with a built-in keyboard, and never with a mouse. VDTs are still prevalent today, and are used with some Sun, Unix and Linux systems as well as mainframes.

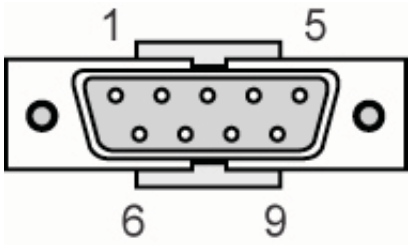


Serial Data Connectors for ASCII Terminal Interface (DB-9 & DB-25)

Digital Video

Early PC monitors utilized digital TTL signals (Transistor-Transistor Logic) to convey video from the display adapter card to the monitor. The video standards involved are no longer in use, but included: MDA (Monochrome Display Adapter), CGA (Color Graphics

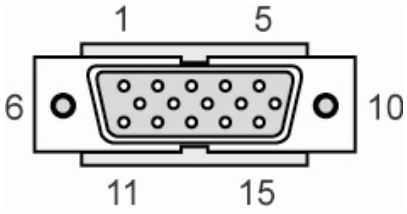
Adapter) and EGA (Extended Graphics Adapter) cards. These cards typically use DB-9 (9-pin D-connector) outputs. These early digital video systems had very low resolution, limited color depth (not many colors could be displayed), and signals could not travel more than about 10 or 15 feet without visible degradation.



CGA-EGA Video Connector (DB-9)

Analog Video

Analog video signals eventually replaced the TTL digital format. Here, the video intensity is defined by a continuously-variable voltage that typically ranges from zero to 700 millivolts (mV) DC per color. Analog-based video started out as VGA (Versatile Graphics Array), and then expanded to include SVGA (Super VGA), and XGA (Extended Graphics Array) cards, among others. Analog cards typically use HDB-15 (15- pin D-connector with 3 rows of pins) outputs. However, all 15 pins are not utilized for signals with some systems using pins to convey coded information about the monitor back to the video card. Analog video immediately increased the available resolution, color depth, and cable length well beyond what early digital video could accommodate. Most VGA-capable monitors sold today will work with almost any vintage VGAstandard video output card, though there are some caveats.



VGA Video Connector (HDB-15)

The Video Resolution Revolution – Modern Video Standards

Analog – VGA Still Thrives

Much of today’s video remains analog. From the early 640 x 480 pixel ‘standard VGA’ resolution, VGA style video cards and monitors capable of up to 2048 x 1536 pixels have emerged, and some cards can drive multiple high-resolution monitors to create an even larger “virtual” screen image. Computer monitors have also grown in screen real estate – the 1970s typical 12” diagonal display has today become a 20”, 24” and even 30” monitor that is prevalent in some offices and data centers (not to mention the projection systems). Simultaneously, color depth has increased with the maximum number of colors displayed expanding from 16 or 256 colors up to millions.

CRT Paves Way for LCD

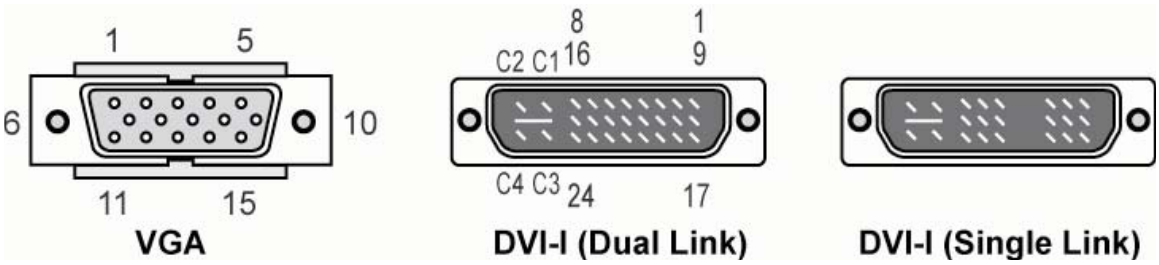
The biggest impact in computer video has been the shift from CRT (cathode ray tube) to flat screen monitors. Typically, the flat screen used in a data center is an LCD (liquid crystal display) though some plasma and other technologies are used for larger screens. These monitors have emerged as an attractive option due to lower energy usage, reduced footprint, and greater edge-to-edge sharpness. The combination of its resilience (LCDs last three times longer than a CRT) with affordability over the last few years has made the LCD a much more affordable alternative. LCDs are now the de-facto standard for the desktop, server room and data center. This swing towards LCDs has contributed to a resurgence of digital video output cards.

Analog Returning to Digital?

While early LCDs almost universally included VGA input connections, the LCD monitor is an inherently digital display device with specific transistor junctions controlling each pixel on the screen; this differs from the CRT, where early digital signals had to be reconverted back to analog to drive the electron gun and deflection magnets that ‘painted’ the electron beam across the phosphor-coated screen surface. To address this issue, many LCDs, particularly larger screens, now offer both DVI (Digital Video Interface) and VGA (analog) connections.

Video Display Formats – Which one is Best?

Which display format is best? Then answer depends on the application and the source of the video. In terms of KVM technology, the VGA input is the best choice – the white paper will discuss this in more detail in the next section.



Analog-Only VGA vs. DVI-I Combination Digital-Analog Video Male Connectors
(Dual link DVI sources have higher resolution than Single link DVI sources)

Display Data Channel

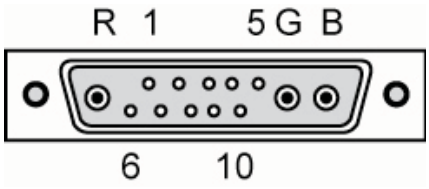
The Display Data Channel or DDC describes a digital link, or a channel between a computer display and a graphics adapter, that allows the display to communicate its specifications to the adapter. The DDC standard was created by the Video Electronics Standards Association (VESA). DDC uses 3 pins (data/clock/ground) which may be carried in a VGA, DVI or HDMI connector.

KVM switches that are “DDC-ready” will pass the DDC data between monitor and computers – otherwise, the DDC functionality that works on a direct PC-to-monitor connection will be disabled when going through the “non DDC-aware” KVM.

Multiplatform Video

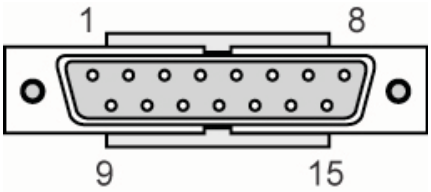
Microsoft Windows has long been the standard for many data processing environments, although Sun Microsystems has carved a large niche and Apple’s Macintosh is on the rise again. Silicon Graphics (SGI) made inroads into the data center with its high-powered graphics-intensive systems using a proprietary video. One school of thought equated “multi-platform” with different types of video, but that is not as prevalent except for DVI vs. VGA in limited areas.

Today’s Sun computers all have standard VGA connectivity which eliminates the need for an adaptor.



Early Sun Video Connector (13W3)

Ten years ago, Apple began shipping systems with VGA video out. In the last few years, Apple has adopted DVI-I and includes an adaptor cable for users to connect its computers to standard VGA monitors or KVM switch inputs.



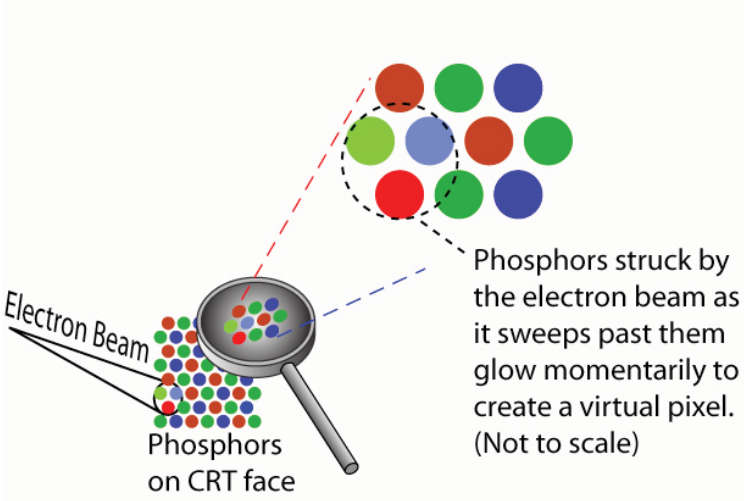
Early Macintosh Video Connector (D15)

Flat Panel Displays and KVM Switches – Words of Wisdom

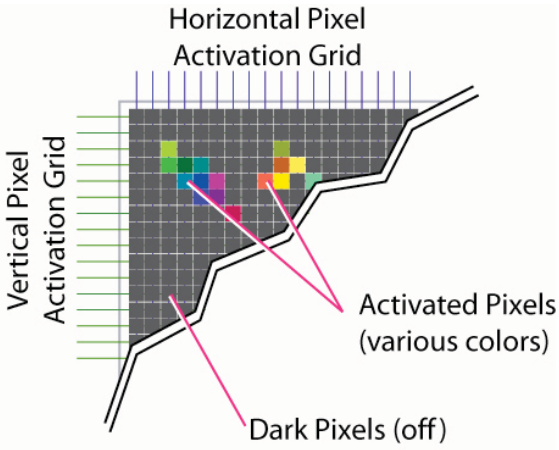
In the past, a CRT delivered a sharp, clear image with a variety of incoming signals, making it an excellent choice for use with a KVM switch, particularly if the computers connected to the switch have different video output settings.

The advent and mass acceptance of flat panel LCD is attributed to its ability to better display the pixels. Each pixel is controlled by a transistor that causes the liquid crystal next to it to become opaque or transparent to light transmission. There is also a backlight within the screen. Energizing or de-energizing a given transistor twists the polarization of light by its liquid crystal and either allows or blocks the backlight from reaching the viewer.

An LCD (or plasma) flat panel display has a fixed number of pixels – each pixel is a liquid crystal element controlled by its own transistor. Unlike the CRT with a continuously variable electron beam, a LCD offers an array of horizontal and vertical pixels that work at a single bitmap resolution – this becomes the “native” or “optimum” screen resolution for the particular LCD monitor.


Electron Beam
Phosphors on CRT face
Phosphors struck by the electron beam as it sweeps past them glow momentarily to create a virtual pixel. (Not to scale)

Cathode Ray Tube - Pixels encompass multiple tiny phosphors and can thus be ‘painted’ in any position by the electron beam thanks to multi-sync technology.



LCD Display - Pixels are fixed in size and position, activated to whatever color and transparency is dictated by horizontal and vertical activation grid lines. Any resolution other than this ‘optimum’ bitmap will not be as sharp.

The difference between CRT and LCD monitors makes it imperative to set all computers connected to a KVM with an LCD monitor to the same video resolution, one that matches the optimum LCD screen resolution.

For optimal resolution on a LCD monitor, set all KVM-controlled computers to the same video output resolution, and make sure the monitor has that resolution as its native (optimum) specified resolution.

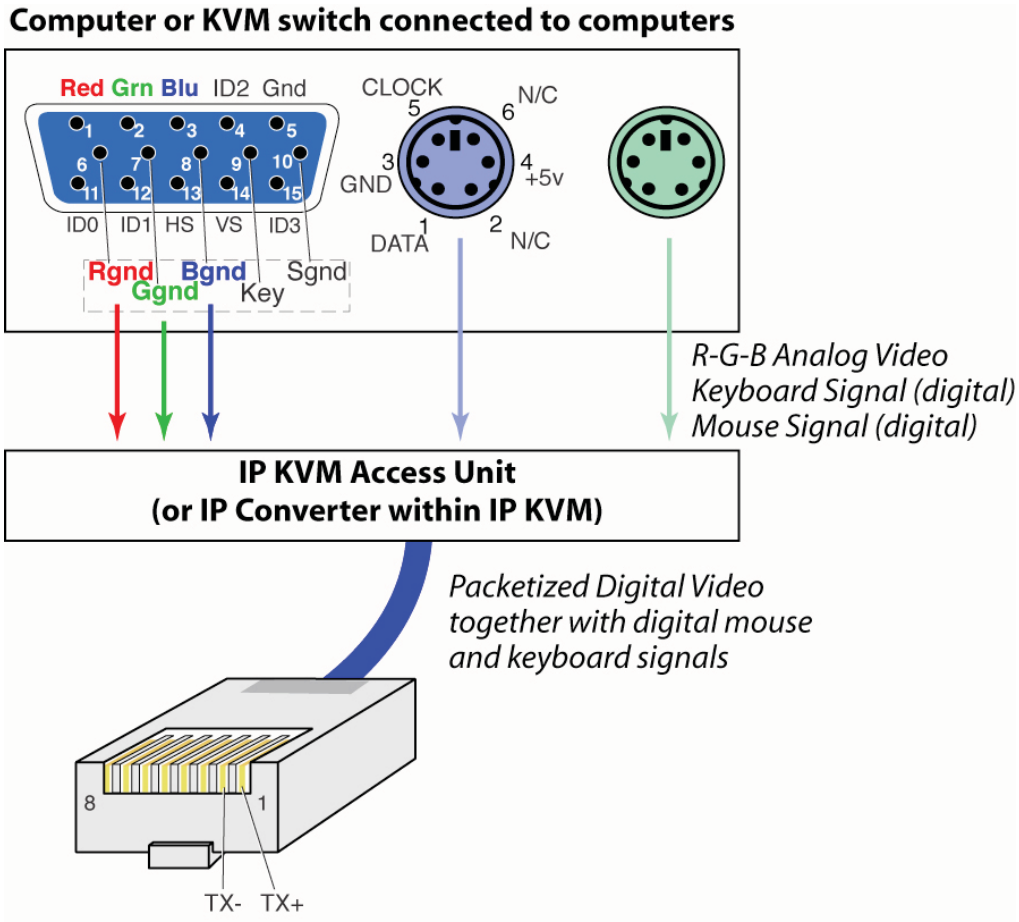
Video Settings for IP-KVM

When computer video is conveyed over a TCP/IP network, resolution must be treated differently as much changes with handling video locally over analog (or even digital) wired systems. With direct wiring between the computer(s) and the monitor, via a KVM switch, the resolution and refresh rate generated by the computer’s video card is delivered to the monitor – KVM switches do not change these values but simply pass them through. On the flip side, this process does not occur when the video is sent over a network via the local LAN or a WAN or Internet connection.

All IP KVM switches, as well as IP Access Units (converters for use with conventional KVM switches) process the source video, typically converting it from analog Red-Green- Blue and Sync signals on separate pairs of wires to a single digitized signal that goes out in the form of numerical packets on just one pair of wires. While the signal leaves the IP

KVM on a 4-pair Cat 5 or Cat 6 cable, only 2 conductors carry the outgoing video signal along with keyboard and mouse components. The video, keyboard and mouse control are carried through DSL or TV cable internet connections either of which uses just two
wires.

To perform this conversion from a relatively fast analog video format to a slower digital format, “frame grabbing” is used in conjunction with various compression methods to reduce the amount of band-width required to convey the video.



While IP KVM video over the Internet may take longer to appear and refresh than local video, it offers a better option than driving across town or flying to a destination to control the computers.

To optimize the video signals over an IP KVM connection, the key is reducing the video quality settings on the controlled computers:

- Use a lower bitmap of 800 x 600 or 1024 x 768 pixels even though the IP KVM may support higher resolutions
- Try a lower refresh rate of 60 Hz instead of 65 to 80 Hz
- Lower the color depth setting the computer to 256 or thousands of colors instead of millions

Select IP KVM systems can redraw the screen at a lower image resolution than what is generated from the computer video cards. However, this consumes processing time and

reduces the sharpness relative to passing video though at the native resolution. When using an IP KVM, it is critical to characterize the primary mode of access to the controlled computers. If the IP KVM is used for occasional monitoring and maintenance, then optimize video card settings for the local access. If IP KVM is the primary mode of access, then optimize video card settings for that purpose.

De-mystifying Video Resolution Specifications

Although a network administrator may know the bitmap resolution, refresh rate, color depth, and the type of connector, it is not enough information to help in the selection of the best KVM switch and monitor.

Other factors include knowledge of the highest resolution video to accommodate the KVM switch and sharpness of the video. Without clearly defined industry standards on “sharpness” or “clarity”, or even how to specify video bandwidth, there are other factors to understand when specifying and setting up a KVM system.

A typical KVM switch video specification might read as follows:

CONSERVATIVE-RATED KVM SWITCH MODEL A:

Format	VGA
Resolution (w/ 200 ft total cable)	1600 H x 1280 V @70 Hz
Maximum Cable Length	500 ft
Bandwidth	200 MHz

Compare this to Switch B below. It would seem that Switch A is inferior to Switch B.

OPTIMISTICALLY-RATED KVM SWITCH MODEL B:

Format	WUXGA
Resolution (w/ 200 ft total cable)	1920 H x 1200 V
Maximum Cable Length	1,000 ft
Bandwidth	300 MHz

While it appears that Switch B is better, in reality it is not. The above specs can be misleading and omit the proper definitions of terms and limits for measurement. Hence, these numbers are suspect if not meaningless.

This example is not given to criticize manufacturers that have comparable specs but it presents challenges to network administrators in the selection process. KVM manufacturers should provide detailed specs to more accurately portray video resolution:

SWITCH MODEL A *(The Detailed Spec):*

Format	UXGA
Resolution (w/ 200 ft total cable)	1600 H x 1280 V @ 75 Hz (1920 H x 1200 V @ 65 Hz)
Maximum Cable Length	500 ft console-to-computer, 1280 x 1024 @ 70 Hz,
	1000 ft console-to-computer, 1024 x 768 @ 65 Hz
Bandwidth	200 MHz, -3 dB (300 MHz, -12 dB)

SWITCH MODEL B *(The Detailed Spec):*

Format	UXGA
Resolution (w/ 200 ft total cable)	1600 H x 1280 V @ 65 Hz (1920 H x 1200 V @ 50 Hz)
Maximum Cable Length	500 ft console-to-computer, 1280 x 1024 @ 65 Hz,
	1000 ft console-to-computer, 800 x 600 @ 60 Hz
Bandwidth	200 MHz, -6 dB (300 MHz, -18 dB)

As a guiding principle in video, the better set of electronic circuitry (wider bandwidth, lower impedance, better output amplifiers and internal buffering), the higher the resolution and the shaper the image at the end of a given length of cable.

Refresh Rate is an often ‘hidden’ spec. Listed in Hz (Hertz, which here means video frames per second), the maximum supported refresh rate will vary with the chosen resolution (HxV pixel bitmap).

Higher refresh rates at any given resolution require a wider video bandwidth (see below) which in turn demands better components in the KVM switch and better quality cabling. In the example above, Switch A really did not deliver 1920 x 1200 pixels on a par with Switch B. However, Switch B delivered that resolution at 50 Hz versus Switch A at 65 Hz. Switch A’s conservative manufacturer decided to advertise a resolution at a better refresh rate of 75 Hz. Note that at the same 1600 x 1280 resolution cited by Switch A, the initially “better looking” Switch B can only deliver a 65 Hz refresh rate – substantially worse.

Bandwidth is a specification that interests engineers versus end users but can be pretty telling in terms of image sharpness through a KVM switch. Too much bandwidth can allow internal oscillations (feedback) to occur that could degrade the signal and damage a device. Low bandwidth translates to inadequate sharpness or color resolution or just too low of a bitmap (H x V pixels) at a given refresh rate. In order to spec an “honest” 300 MHz bandwidth as noted in the example above, the switch’s video output power should be down 3 dB at 300 MHz.

Screen Resolution	Video Refresh Rate							
	60Hz	65 Hz	70 Hz	75 Hz	80 Hz	85 Hz	90 Hz	100 Hz
640H x 480V	25 MHz	28 MHz	30 MHz	32 MHz	34 MHz	37 MHz	40 MHz	44 MHz
800H x 600V	40 MHz	43 MHz	47 MHz	50 MHz	55 MHz	58 MHz	61 MHz	68 MHz
1024H x 768V	66 MHz	72 MHz	77 MHz	83 MHz	88 MHz	94 MHz	100 MHz	112 MHz
1280H x 1024V	108 MHz	122 MHz	130 MHz	140 MHz	148 MHz	158 MHz	166 MHz	185 MHz
1600H x 1200V	162 MHz	177 MHz	191 MHz	204 MHz	215 MHz	230 MHz	248 MHz	270 MHz
1900H x 1200V	200 MHz	215 MHz	231 MHz	248 MHz	262 MHz	278 MHz	295 MHz	330 MHz

Minimum Video Bandwidth (in Megahertz, approximate) for clear imaging At various refresh rates and screen resolutions. Bandwidth over 200 MHz is needed primarily for higher video resolutions, but 100 MHz is barely adequate for many modern computing environments.

To demystify the specs, Switch A would almost certainly be sharper at any given resolution, and would provide usable video to a greater level resolution than the initially ‘better specified’ Switch B.

Recommendations

The best method to evaluate KVM products is to compare them in actual use and read hands-on reviews. If the manual does not provide all the answers and online resources prove unreliable, contact a knowledgeable manufacturer’s tech support to gain the knowledge.

Summary

Network administrators tend to bypass the critical value and importance of the “V” in KVM. Video resolution, when fully optimized, gives IT administrators more flexibility to configure and position a KVM switch strategically within a server room or enterpriseclass data center. The key to video resolution lies in understanding the technical specs behind the technology and parameters for the best use – especially for IP KVMs.

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